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(54) An exhaust emission purification apparatus and method for an internal combustion engine

Abgasreinigungsvorrichtung und Verfahren für eine Brennkraftmaschine

Dispositif et méthode pour l'épuration des gaz d'échappement d'un moteur à combustion interne

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- **PATENT ABSTRACTS OF JAPAN vol. 096, no. 006, 28 June 1996 & JP 08 049526 A (NISSAN DIESEL MOTOR CO LTD), 20 February 1996,**
- **PATENT ABSTRACTS OF JAPAN vol. 016, no. 561 (M-1341), 3 December 1992 & JP 04 214919 A (TOYOTA MOTOR CORP), 5 August 1992,**

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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to an exhaust emission purification apparatus for an internal combustion engine or, in particular, to an exhaust emission purification apparatus for an internal combustion engine using a lean NO_x catalyst.

2. Description of the Related Art

[0002] A three-way catalyst for purifying carbon monoxide, hydrocarbon and nitrogen oxides at the same time has found application as an exhaust emission purification apparatus for an internal combustion engine. For the exhaust emission gas to be efficiently purified by a three-way catalyst, however, it is necessary that the air-fuel ratio of the mixture supplied to the internal combustion engine is maintained at substantially a stoichiometric air-fuel ratio.

[0003] However, in the case where a three-way catalyst is used for a lean-burn internal combustion engine in which the air-fuel ratio of the mixture is set lean while the vehicle is running normally in order to reduce the fuel consumption, the carbon monoxide and hydrocarbon can be removed but the nitrogen oxide cannot be removed. For this reason, a lean NO_x catalyst using zeolite ion-exchanged with a transition metal has been developed and finds practical applications.

[0004] When NO_x is to be purified by the lean NO_x catalyst, the presence of a hydrocarbon is essential, and it is necessary to supply a hydrocarbon upstream of the lean NO_x catalyst.

[0005] Because the hydrocarbon thus supplied generates heat when being oxidized in the lean NO_x catalyst, the temperature of the lean NO_x catalyst increases excessively and sometimes deviates from a temperature range (window) in which the catalyst is to be operated.

[0006] In an attempt to solve this problem, document JP-A-04-214919 proposes an exhaust emission purification apparatus for internal combustion engines, in which the amount of hydrocarbon to be supplied is controlled on the basis of the state variables (including the lean NO_x catalyst temperature, the space velocity representing the exhaust gas flow rate through the lean NO_x catalyst, or the engine speed and the accelerator opening) representing the operating conditions of the lean NO_x catalyst.

[0007] Further, JP-A-08-049526 discloses an exhaust emission gas purification apparatus and method in which the supply of hydrocarbon is decreased or stopped when the temperature at the outlet or center of a lean NO_x catalyst exceeds a predetermined temperature.

[0008] Finally, document EP-A-0 498 598 discloses an exhaust emission gas purification system according to the preambles of claims 1 and 8, respectively. A long-term thermal degradation of a lean NO_x catalyst is compensated by calculating the catalyst degradation extent on the basis of a temperature difference between an exhaust gas temperature detected by temperature sensors at the inlet and the outlet of the lean NO_x catalyst and by providing a proper hydrocarbon supply amount which prevents the temperature of the catalyst from deviating outside a temperature window for achieving a proper purification rate. The larger the catalyst degradation extent is, the more hydrocarbon is supplied to the catalyst to change the catalyst temperature to a higher temperature side. In this way, the catalyst can be operated with a considerably high NO_x purification rate even after the catalyst has been thermally degraded.

SUMMARY OF THE INVENTION

[0009] According to the state of the art, however, the amount of hydrocarbon to be supplied corresponds to state variables which are substantially steady. Under transient operating conditions such as accelerating or decelerating conditions, a catalyst temperature deviation to outside the desired temperature window and a deterioration of the purification rate are unavoidable.

[0010] Fig. 1 is a diagram for explaining the above-mentioned problem, in which the abscissa represents the time and the ordinate the temperature.

[0011] Specifically, in the steady state at and before time t_1, the catalyst temperature T_c is higher than the exhaust gas emission temperature T_{gi} at the catalyst inlet due to heat generated by the oxidation of the supplied hydrocarbon.

[0012] When the acceleration starts at time t_1, the inlet exhaust gas temperature T_{gi} rises, so that the lean NO_x catalyst begins to be heated after t_2 when the inlet exhaust gas temperature T_{gi} exceeds the catalyst temperature T_c.

[0013] Due to the thermal capacity of the lean NO_x catalyst, however, the catalyst temperature T_c does not rise immediately, but begins to rise only at t_3, and deviates from the temperature window at the time t_4.

[0014] The same problem occurs also in the deceleration condition, when the catalyst temperature T_c begins to drop and deviates from the temperature window some time after the deceleration starts.

[0015] The present invention has been developed in view of the above-mentioned problem, and the object thereof is to provide an exhaust emission gas purification apparatus and method for an internal combustion engine capable of maintaining a proper purification rate even under transient operating conditions of the internal combustion engine.

[0016] The above object is achieved by an exhaust emission gas purification apparatus as set out in claim 1 and by an exhaust emission gas purification method

as set out in claim 8.

[0017] In this apparatus and method, the basic amount of hydrocarbon supplied for reducing NO_x is corrected when the temperature difference between the inlet exhaust gas temperature and the catalyst temperature deviates from a predetermined value corresponding to the amount of heat generated by the basic amount of hydrocarbon. Even in the case where the inlet exhaust gas temperature undergoes a transient fluctuation, therefore, an excessive temperature fluctuation of the lean NO_x catalyst can be suppressed, thereby preventing the lean NO_x catalyst temperature from deviating outside a desired window set for achieving a proper purification rate.

[0018] A diesel fuel injection hole 311 is inserted in the exhaust pipe 306 upstream of the exhaust gas purification apparatus 307. The diesel fuel stored in a diesel fuel tank 312, pressured by a diesel fuel pump 313 and functioning as a NO_x reducing agent is injected into the exhaust gas. The injected amount of the diesel fuel thus is controlled by adjusting the opening of a solenoid valve 314.

[0019] An inlet exhaust gas temperature sensor 321 and an outlet exhaust gas temperature sensor 322 for detecting the temperature of the exhaust gas are installed at the inlet and the output, respectively, of the exhaust gas purification apparatus 307. According to this embodiment, it is difficult to detect the temperature of the lean NO_x catalyst directly, and therefore the temperature detected by the outlet exhaust gas temperature sensor 322 is used as a catalyst temperature.

[0020] The exhaust gas purification apparatus for the internal combustion engine described above is controlled by a controller 33 constituting a microcomputer system. The controller 33 includes a bus 331, a CPU 332, a memory 333, an output interface 334 and an input interface 335 built around the bus 331.

[0021] The input interface 335 is connected with an internal combustion engine speed sensor 304, an air flowmeter 302, an inlet exhaust gas temperature sensor 321 and an outlet exhaust gas temperature sensor 322. The outlet interface 334 is connected with the solenoid valve 314.

[0022] Fig. 3 is a flowchart showing a diesel fuel supply amount control routine stored in the memory 33 and executed in the CPU 332.

[0023] Step 402 fetches the intake air amount Q_a detected by the air flowmeter 302, the inlet exhaust gas temperature T_{gi} detected by the inlet exhaust gas temperature sensor 321 and the outlet exhaust gas temperature T_{go} detected by the outlet exhaust gas temperature sensor 322.

[0024] Step 404 calculates the space velocity SV which is a state variable representing the operating conditions of the exhaust gas purification apparatus 307 on the basis of the intake air amount Q_a.

$$SV \leftarrow SV(Q_a)$$

[0025] Then, step 406 calculates the basic diesel fuel supply amount HC_{base} as a function of the outlet exhaust gas temperature T_{go} used in place of the catalyst temperature and the space velocity SV.

$$HC_{base} \leftarrow HC_{base}(SV, T_{go})$$

[0026] Fig. 4 is a map for determining the basic diesel fuel supply amount HC_{base}, in which the abscissa represents the space velocity SV, the ordinate the outlet exhaust gas temperature T_{go} and the contour lines the basic diesel fuel supply amount HC_{base}. The basic diesel fuel supply amount HC_{base} increases progressively from HC_{base0} toward HC_{base3}. Further, Fig. 4 shows cross sections taken in lines X_1-X_1, X_2-X_2, X_3-X_3.

[0027] Specifically, the basic diesel fuel supply amount HC_{base} assumes an angular shape in the window area with the supply amount which is highest at the center and reduced progressively toward the boundaries. Upon deviation from the window, the supply amount becomes zero. In other words, the height of each cross section represents the basic diesel fuel supply amount HC_{base}.

[0028] More specifically, the basic diesel fuel supply amount HC_{base} has an angular shape which is progressively higher toward the upper right (in the direction of arrow Y). In this way, the basic diesel fuel supply amount HC_{base} increases.

[0029] Step 408 calculates the temperature difference ΔT between the inlet exhaust gas temperature T_{gi} and the outlet exhaust gas temperature T_{go}. Step 410 calculates the correcting diesel fuel supply amount ΔHC as a function of the temperature difference ΔT.

$$\Delta T \leftarrow T_{gi} - T_{go}$$

$$\Delta HC \leftarrow \Delta HC(\Delta T)$$

[0030] Fig. 5 is a map for determining the correcting diesel fuel supply amount ΔHC, in which the abscissa represents the temperature difference ΔT and the ordinate the correcting diesel fuel supply amount ΔHC.

[0031] Specifically, in order to set the correcting diesel fuel supply amount ΔHC to zero in a steady state, the abscissa is crosses the abscissa at a point "a" representing the state in which the outlet exhaust gas temperature T_{go} is higher than the inlet exhaust gas temperature T_{gi} by the amount of heat generated by the basic diesel fuel supply amount HC_{base}.

[0032] The larger the temperature difference ΔT becomes, i.e., the more the lean NO_x catalyst is heated due to the rise of the inlet exhaust gas temperature T_{gi},

the more the correcting diesel fuel supply amount ΔHC is reduced (the absolute value is increased in the negative direction) to suppress the temperature increase of the lean NO_x catalyst. In the case where the inlet exhaust gas temperature T_{gi} drops, on the other hand, the correcting diesel fuel supply amount ΔHC is increased in order to increase the temperature of the lean NO_x catalyst.

[0033] Note, because the outlet exhaust gas temperature is increased by the oxidizing heat of the supplied diesel fuel, an immediate decreasing correction is not required when the inlet exhaust gas temperature drops under the lower limit temperature of the window.

[0034] Namely, diesel fuel supply amount may be corrected after the temperature difference ΔT becomes smaller than the temperature which corresponds to $2 \times HC_{base}$.

[0035] Fig. 5 shows a linear function. Other functions can alternatively be used as far as the relation is held that with the increase in the temperature difference ΔT, the correcting diesel fuel supply amount ΔHC decreases, while with the decrease in the temperature difference ΔT, the correcting diesel fuel supply amount ΔHC increases.

[0036] Step 412 calculates the diesel fuel supply amount HC by adding the basic diesel fuel supply amount HC_{base} to the correcting diesel fuel supply amount ΔHC. Step 414 supplies a pulse train having a duty factor corresponding to the diesel fuel supply amount HC to the solenoid valve 314 through the output interface 334, and thus controls. the amount of the diesel fuel injected from the diesel fuel injection hole 311.

[0037] Fig. 6A and 6B are diagrams for explaining the effects of the present invention, in which the abscissa represents the time, and the ordinate the temperature (upper part) and the diesel fuel supply amount (lower part).

[0038] In the upper part of the graph, the solid line represents the inlet exhaust gas temperature T_{gi} and the dashed line the catalyst temperature T_c. In the two graphs, the thick dashed line represents an application of the present invention, and the thin dashed line the case in which the present invention is not applicable.

[0039] Assume that the engine is operating at point A (Fig. 4) where the space velocity is SV_1 and the outlet exhaust gas temperature is T_{go} (i.e., the catalyst temperature is T_c) in steady state at or before time point t_1.

[0040] First, consider the case where the invention is not applicable, i.e., the case where only the basic diesel fuel supply amount is used. The condition involved is described below.

[0041] At t_1 when acceleration starts, the intake air amount increases and so does the space velocity. In spite of this, the catalyst temperature T_c remains substantially unchanged due to the thermal capacity of the lean NO_x catalyst. As a result the operation point moves rightward from point A so that, as shown by the thin dashed line in the lower part of the graph, the amount of diesel fuel supplied steadily increases and reaches a maximum point at time t_2 when the inlet exhaust gas temperature T_{gi} reaches a maximum.

[0042] In this way, the amount of heat received by the lean NO_x catalyst increases not only with the temperature increase of the exhaust gas but with the increase in the amount of diesel fuel supplied. As shown by the thin dashed line in the upper part of the graph, therefore, the catalyst temperature T_c gradually increases to such an extent that it deviates from the window at time t_3.

[0043] According to the present invention, in contrast, with the increase of the inlet exhaust gas temperature T_{gi} from time point t_1, the temperature difference ΔT between the inlet exhaust gas temperature T_{gi} and the outlet exhaust gas temperature T_{go} increases. As shown by the thick dashed line in the lower part of the graph, therefore, the correcting diesel fuel supply amount ΔH suppresses the increase in the diesel fuel supply amount.

[0044] Consequently, in spite of the fact that the amount of heat received by the lean NO_x catalyst increases with the temperature of the exhaust gas, the diesel fuel supply amount is suppressed, so that the heat generated by the NO_x reduction due to the diesel fuel is rather reduced. As shown by the thick dashed line in the upper part of the graph, therefore, the catalyst temperature T_c is prevented from deviating from the window.

[0045] The basic diesel fuel supply amount HC_{base}, which is determined from the map of the catalyst temperature represented by the outlet exhaust gas temperature T_{go} and the space velocity SV according to the present embodiment, can alternatively be determined from the map of the intake air amount and the rotational speed of the internal combustion engine. In such a case, the speed of the internal combustion engine is detected by the rpm sensor 304.

[0046] Note, this invention can be applied when the vehicle is running under steady state condition and the inlet exhaust gas temperature and the catalyst temperature are within the window.

[0047] Further, although the diesel fuel is used as a hydrocarbon for reducing NO_x in the above-mentioned embodiment, other hydrocarbon materials such as alcohol can be used with equal effect.

Claims

1. An exhaust emission gas purification apparatus for an internal combustion engine, comprising:

   a lean NO_x catalyst (307) arranged in the exhaust pipe (306) of an internal combustion engine (30);
   a hydrocarbon supply means (311) for supplying hydrocarbon into the exhaust gas for reducing NO_x upstream of said NO_x catalyst;

a state variables detection means (302, 304, 321, 322) for detecting state variables (Q_a, T_{gi}, T_c) representing the operating conditions of said lean NO_x catalyst;

a basic hydrocarbon supply amount determining means (33) for determining the basic amount of hydrocarbon (HC_{base}) supplied from said hydrocarbon supply means (311) in accordance with the state variables detected by said state variables detection means; and

a temperature difference detection means (321, 322) for detecting the difference (ΔT) between the exhaust gas temperature (T_{gi}) at the inlet of said lean NO_x catalyst and the temperature (T_c) of the lean NO_x catalyst which are included in the state variables detected by said state variables detection means,

characterized by

a hydrocarbon supply amount correction means (33) for correcting the basic amount of hydrocarbon (HC_{base}) determined by said basic hydrocarbon supply amount determining means when the temperature difference (ΔT) detected by said temperature difference detection means (321, 322) deviates from a predetermined value (a; 2a) corresponding to an amount of heat generated by the basic amount of hydrocarbon (HC_{base}) supplied from said hydrocarbon supply means (311) so as to prevent the temperature (T_c) of said lean NO_x catalyst from deviating outside a temperature window set for achieving a proper purification rate.

2. An exhaust emission gas purification apparatus for internal combustion engines according to claim 1, wherein said predetermined value (a; 2a) is greater when the exhaust gas temperature (T_{gi}) at the inlet of said lean NO_x catalyst drops.

3. An exhaust emission gas purification apparatus for internal combustion engines according to claim 1 or 2,
wherein said hydrocarbon supply amount correction means (33) uses a linear function for correcting the basic amount of hydrocarbon (HC_{base}) in accordance with the temperature difference (ΔT).

4. An exhaust emission gas purification apparatus for internal combustion engines according to claim 1, wherein said state variables detection means includes an intake air amount detection means (302) for detecting the intake air amount (Q_a) of the internal combustion engine, and a lean catalyst temperature detection means (322) for detecting the temperature (T_c) of said lean NO_x catalyst.

5. An exhaust emission gas purification apparatus for internal combustion engines according to claim 4, wherein said lean catalyst temperature detection means (322) detects the exhaust gas temperature (T_{go}) at the outlet of said lean NO_x catalyst.

6. An exhaust emission gas purification apparatus for internal combustion engines according to claim 1, wherein said state variables detection means includes an intake air amount detection means (302) for detecting the intake air amount (Q_a) of the internal combustion engine, and an engine speed detection means (304) for detecting the rotational speed of the internal combustion engine.

7. An exhaust emission gas purification apparatus for internal combustion engines according to claim 1, wherein said temperature difference detection means (321, 322) detects the difference (ΔT) in the exhaust gas temperature between the inlet and the outlet of said lean NO_x catalyst.

8. An exhaust emission gas purification method for internal combustion engines, comprising the steps of:

supplying hydrocarbon into the exhaust gas for reducing the NO_x upstream of a lean NO_x catalyst (307) arranged in the exhaust pipe (306) of an internal combustion engine (30);

detecting state variables (Q_a, T_{gi}, T_c) representing the operating conditions of said lean NO_x catalyst; and

determining the basic amount of hydrocarbon (HC_{base}) supplied in said hydrocarbon supply step in accordance with the state variables detected in said state variables detection step; and

detecting the difference (ΔT) between the temperature of the exhaust gas (T_{gi}) at the inlet of said lean NO_x catalyst and the temperature (T_c) of said lean NO_x catalyst which are included in the state variables detected at said state variables detection step,

characterized by

correcting the basic amount of hydrocarbon (HC_{base}) determined in said basic hydrocarbon supply amount determining step when the temperature difference (ΔT) detected in said temperature difference detection step deviates from a predetermined value (a; 2a) corresponding to an amount of heat generated by the basic amount of hydrocarbon (HC_{base}) supplied in said hydrocarbon supply step so as to prevent the temperature (T_c) of said lean NO_x catalyst from deviating outside a temperature window set for achieving a proper purification rate.

9. An exhaust emission gas purification method for internal combustion engines according to claim 8,

wherein said predetermined value (a; 2a) is greater when the exhaust gas temperature (T_{gi}) at the inlet of said lean NO_x catalyst drops.

10. An exhaust emission gas purification method for internal combustion engines according to claim 8 or 9, wherein said hydrocarbon supply amount correction step uses a linear function for correcting the basic amount of hydrocarbon (HC_{base}) in accordance with the temperature difference (ΔT).

11. An exhaust emission gas purification method for internal combustion engines according to claim 8, wherein said state variables detection step includes the steps of detecting the intake air amount (Q_a) of the internal combustion engine, and detecting the temperature (T_c) of said lean NO_x catalyst.

12. An exhaust emission gas purification method for internal combustion engines according to claim 11, wherein in said lean catalyst temperature detection step the exhaust temperature (T_{go}) is detected at the outlet of said lean NO_x catalyst.

13. An exhaust emission gas purification method for internal combustion engines according to claim 8, wherein said state variables detection step includes the steps of detecting the intake air amount (Q_a) of the internal combustion engine, and detecting the rotational speed of the internal combustion engine.

14. An exhaust emission gas purification method for internal combustion engines according to claim 8, wherein in said temperature difference detection step the difference (ΔT) in the exhaust gas temperature is detected between the inlet and the outlet of said lean NO_x catalyst.

Patentansprüche

1. Abgasemissionsreinigungsgerät für eine Brennkraftmaschine mit:

einem Mager-NO_x-Katalysator (307), der in der Abgasleitung (306) einer Brennkraftmaschine (30) angeordnet ist;
einer Kohlenwasserstoffzuführeinrichtung (311) zum Zuführen von Kohlenwasserstoff in das Abgas zum Reduzieren von NO_x stromaufwärts des NO_x-Katalysators;
einer Zustandsgrößenermittlungseinrichtung (302, 304, 321, 322) zum Ermitteln von Zustandsgrößen (Q_a, T_{gi}, T_c), die die Betriebszustände des Mager-NO_x-Katalysators darstellen;
einer Basiskohlenwasserstoffzuführmengenbestimmungseinrichtung (33) zum Bestimmen der Basismenge an Kohlenwasserstoff (HC_{Basis}), der von der Kohlenwasserstoffzuführeinrichtung (311) entsprechend den Zustandsgrößen zugeführt wird, die durch die Zustandsgrößenermittlungseinrichtung ermittelt werden; und
einer Temperaturunterschiedermittlungseinrichtung (321, 322) zum Ermitteln des Unterschieds (ΔT) zwischen der Abgastemperatur (T_{gi}) an dem Einlass des Mager-NO_x-Katalysators und der Temperatur (T_c) des Mager-NO_x-Katalysators, die in den Zustandsgrößen enthalten sind, die durch die Zustandsgrößenermittlungseinrichtung ermittelt werden,

gekennzeichnet durch

eine Kohlenwasserstoffzuführmengenkorrigiereinrichtung (33) zum Korrigieren der Basismenge an Kohlenwasserstoff (HC_{Basis}), die **durch** die Basiskohlenwasserstoffzuführmengenbestimmungseinrichtung bestimmt wird, wenn der Temperaturunterschied (ΔT), der **durch** die Temperaturunterschiedermittlungseinrichtung (321, 322) ermittelt wird, von einem vorgegebenem Wert (a; 2a) entsprechend einer Wärmemenge abweicht, die **durch** die Basismenge an Kohlenwasserstoff (HC_{Basis}) erzeugt wird, die von der Kohlenwasserstoffzuführeinrichtung (311) zugeführt wird, so dass verhindert ist, dass die Temperatur (T_c) des Mager-NO_x-Katalysators nach außerhalb eines Temperaturintervalls abweicht, das so gewählt ist, dass eine geeignete Reinigungsrate erzielt wird.

2. Abgasemissionsreinigungsgerät für Brennkraftmaschinen nach Anspruch 1, wobei der vorgegebene Wert (a; 2a) größer ist, wenn die Abgastemperatur (T_{gi}) an dem Einlass des Mager-NO_x-Katalysators fällt.

3. Abgasemissionsreinigungsgerät für Brennkraftmaschinen nach Anspruch 1 oder 2, wobei die Kohlenwasserstoffzuführmengenkorrigiereinrichtung (33) eine lineare Funktion zum Korrigieren der Basismenge an Kohlenwasserstoff (HC_{Basis}) in Übereinstimmung mit dem Temperaturunterschied (ΔT) verwendet.

4. Abgasemissionsreinigungsgerät für Brennkraftmaschinen nach Anspruch 1, wobei die Zustandsgrößenermittlungseinrichtung eine Einlassluftmengenermittlungseinrichtung (302) zum Ermitteln der Einlasssuftmenge (Q_a) der Brennkraftmaschine und eine Magerkatalysatortemperaturermittlungseinrichtung (322) zum Ermitteln der Temperatur (T_c) des Mager-NO_x-Katalysators hat.

5. Abgasemissionsreinigungsgerät für Brennkraftmaschinen nach Anspruch 4, wobei die Magerkatalysatortemperaturermittlungseinrichtung (322) die Abgastemperatur (T_{go}) an dem Auslass des Mager-NO_x Katalysators ermittelt.

6. Abgasemissionsreinigungsgerät für Brennkraftmaschinen nach Anspruch 1, wobei die Zustandsgrößenermittlungseinrichtung eine Einlassluftmengenermittlungseinrichtung (302) zum Ermitteln der Einlassluftmenge (Q_a) der Brennkraftmaschine und eine Motordrehzahlermittlungseinrichtung (304) zum Ermitteln der Drehzahl der Brennkraftmaschine hat.

7. Abgasemissionsreinigungsgerät für Brennkraftmaschinen nach Anspruch 1, wobei die Temperaturunterschiedermittlungseinrichtung (321, 322) den Unterschied (ΔT) in der Abgastemperatur zwischen dem Einlass und dem Auslass des Mager-NO_x-Katalysators ermittelt.

8. Abgasemissionsreinigungsverfahren für Brennkraftmaschinen mit den Schritten:

Zuführen von Kohlenwasserstoff in das Abgas zum Verringern des NO_x stromaufwärtig eines Mager-No_x-Katalysators (307), der in der Abgasleitung (306) einer Brennkraftmaschine (30) angeordnet ist;
Ermitteln von Zustandsgrößen (Q_a, T_{gi}, T_c), die die Betriebsstände des Mager-NO_x-Katalysators darstellen; und
Bestimmen der Basismenge an Kohlenwasserstoff (HC_{Basis}), der in dem Kohlenwasserstoffzuführschritt entsprechend den Zustandsgrößen zugeführt wird, die in den Zustandsgrößenermittlungsschritt ermittelt werden; und
Ermitteln des Unterschieds (ΔT) zwischen der Temperatur des Abgases (T_{gi}) an dem Einlaß des Mager-NO_x-Katalysators und der Temperatur (T_c) des Mager-NO_x-Katalysators, die in den Zustandsgrößen enthalten sind, die in dem Zustandsgrößenermittlungsschritt ermittelt werden,

gekennzeichnet durch

Korrigieren der Basismenge an Kohlenwasserstoff (HC_{Basis}), die in dem Basiskohlenwasserstoffzuführmengenbestimmungsschritt bestimmt wird, wenn der Temperaturunterschied (ΔT), der in dem Temperaturunterschiedermittlungsschritt ermittelt wird, von einem vorgegebenen Wert (a; 2a) entsprechend einer Wärmemenge abweicht, die **durch** die Basismenge an Kohlenwasserstoff (HC_{Basis}) erzeugt wird, die in dem Kohlenwasserstoffzuführschritt zugeführt wird, so dass verhindert wird, dass die Temperatur (T_c) des Mager-NO_x-Katalysators nach außerhalb eines Temperaturintervalls abweicht, das so gewählt ist, dass eine geeignete Reinigungsrate erreicht wird.

9. Abgasemissionsreinigungsverfahren für Brennkraftmaschinen nach Anspruch 8, wobei der vorgegebene Wert (a; 2a) größer ist, wenn die Abgastemperatur (T_{gi}) an dem Einlaß des Mager-NO_x-Katalysators fällt.

10. Abgasemissionsreinigungsverfahren für Brennkraftmaschinen nach Anspruch 8 oder 9, wobei der Kohlenwasserstoffzuführmengenkorrekturschritt eine lineare Funktion zum Korrigieren der Basismenge an Kohlenwasserstoff (HC_{Basis}) in Übereinstimmung mit dem Temperaturunterschied (ΔT) verwendet.

11. Abgasemissionsreinigungsverfahren für Brennkraftmaschinen nach Anspruch 8, wobei der Zustandsgrößenermittlungsschritt die Schritte ermittelt der Einlassluftmenge (Q_a) der Brennkraftmaschine und Ermitteln der Temperatur (T_c) des Mager-NO_x-Katalysators beinhaltet.

12. Abgasemissionsreinigungsverfahren für Brennkraftmaschinen nach Anspruch 11, wobei in dem Mager-Katalysatorermittlungsschritt die Abgastemperatur (T_{go}) an dem Auslass des Mager-NO_x-Katalysators ermittelt wird.

13. Abgasemissionsreinigungsverfahren für Brennkraftmaschinen nach Anspruch 8, wobei der Zustandsgrößenermittlungsschritt die Schritte Ermitteln der Einlassluftmenge (Q_a) der Brennkraftmaschine und Ermitteln der Drehzahl der Brennkraftmaschine beinhaltet.

14. Abgasemissionsreinigungsverfahren für Brennkraftmaschinen nach Anspruch 8, wobei in dem Temperaturunterschiedermittlungsschritt der Unterschied (ΔT) in der Abgastemperatur zwischen dem Einlass und dem Auslass des Mager-NO_x-Katalysators ermittelt wird.

Revendications

1. Appareil d'épuration des gaz d'émission d'échappement pour un moteur à combustion interne, comprenant :

un catalyseur du NOx au rapport air-carburant pauvre (307) disposé dans le tuyau d'échappement (306) d'un moteur à combustion interne (30) ;

un moyen d'alimentation en hydrocarbure (311) pour délivrer des hydrocarbures dans les gaz d'échappement pour réduire du NOx en amont dudit catalyseur du NOx ;

un moyen de détection de variables d'état (302, 304, 321, 322) pour détecter des variables d'état (Q_a, T_{gi}, T_c) représentant les conditions de fonctionnement dudit catalyseur du NOx au rapport air-carburant pauvre ;

un moyen de détermination de quantité d'alimentation en hydrocarbure de base (33) pour déterminer la quantité de base d'hydrocarbure (HC_{BASE}) délivrée depuis lesdits moyens d'alimentation en hydrocarbure (311) en conformité avec les variables d'état détectées par lesdits moyens de détection de variables d'état ; et

un moyen de détection de différence de température (321, 322) pour détecter la différence (ΔT) entre la température des gaz d'échappement (T_{gi}) au niveau de l'entrée dudit catalyseur du NOx au rapport air-carburant pauvre et la température (T_c) du catalyseur du NOx au rapport air-carburant pauvre qui sont inclues dans les variables d'état détectées par ledit moyen de détection de variables d'état,

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un moyen de correction de quantité d'alimentation en hydrocarbure (33) pour corriger la quantité de base d'hydrocarbure (HC_{BASE}) déterminée par ledit moyen de détermination de quantité d'alimentation en hydrocarbure de base lorsque la différence de température (ΔT) détectée par ledit moyen de détection de différence de température (321, 322) dévie d'une valeur prédéterminée (a ; 2a) correspondant à une quantité de chaleur générée par la quantité de base d'hydrocarbure (HC_{BASE}) délivrée depuis ledit moyen d'alimentation en hydrocarbure (311) de façon à empêcher que la température (T_c) dudit catalyseur du NOx au rapport air-carburant pauvre puisse dévier à l'extérieur d'une fenêtre de température établie pour obtenir un taux d'épuration correct.

2. Appareil d'épuration des gaz d'émission d'échappement pour des moteurs à combustion interne selon la revendication 1, dans lequel ladite valeur prédéterminée (a ; 2a) est plus grande lorsque la température des gaz d'échappement (T_{gi}) au niveau de l'entrée dudit catalyseur du NOx au rapport air-carburant pauvre chute.

3. Appareil d'épuration des gaz d'émission d'échappement pour des moteurs à combustion interne selon la revendication 1 ou 2, dans lequel ledit moyen de correction de quantité d'alimentation en hydrocarbure (33) utilise une fonction linéaire pour corriger la quantité de base d'hydrocarbure (HC_{base}) en conformité avec la différence de température ΔT.

4. Appareil d'épuration des gaz d'émission d'échappement pour des moteurs à combustion interne selon la revendication 1, dans lequel ledit moyen de détection de variables d'état inclut un moyen de détection de quantité d'air d'admission (302) pour détecter la quantité d'air d'admission (Q_a) du moteur à combustion interne, et un moyen de détection de température du catalyseur au rapport air-carburant pauvre (322) pour détecter la température (T_c) dudit catalyseur du NOx au rapport air-carburant pauvre.

5. Appareil d'épuration des gaz d'émission d'échappement pour des moteurs à combustion interne selon la revendication 4, dans lequel ledit moyen de détection de température du catalyseur au rapport air-carburant pauvre (322) détecte la température des gaz d'échappement (T_{go}) au niveau de la sortie dudit catalyseur du NOx au rapport air-carburant pauvre.

6. Appareil d'épuration des gaz d'émission d'échappement pour des moteurs à combustion interne selon la revendication 1, dans lequel ledit moyen de détection de variables d'état inclut un moyen de détection de quantité d'air d'admission (302) pour détecter la quantité d'air d'admission (Q_a) du moteur à combustion interne, et un moyen de détection de vitesse du moteur (304) pour détecter la vitesse de rotation du moteur à combustion interne.

7. Appareil d'épuration des gaz d'émission d'échappement pour des moteurs à combustion interne selon la revendication 1, dans lequel ledit moyen de détection de différence de température (321, 322) détecte la différence (ΔT) de la température des gaz d'échappement entre l'entrée et la sortie dudit catalyseur du NOx au rapport air-carburant pauvre.

8. Procédé d'épuration des gaz d'émission d'échappement pour des moteurs à combustion interne, comprenant les étapes consistant à :

délivrer des hydrocarbures dans les gaz d'échappement pour réduire le NOx en amont d'un catalyseur du NOx au rapport air-carburant pauvre (307) disposé dans le tuyau d'échappement (306) d'un moteur à combustion interne (30) ;

détecter des variables d'état (Q_a, T_{gi}, T_c) représentant les conditions de fonctionnement dudit

catalyseur du NOx au rapport air-carburant pauvre ; et

déterminer la quantité de base d'hydrocarbure (HC_{base}) délivré dans ladite étape d'alimentation en hydrocarbure en conformité avec les variables d'état détectées dans ladite étape de détection des variables d'état ; et

détecter la différence (ΔT) entre la température des gaz d'échappement (T_{gi}) au niveau de l'entrée dudit catalyseur du NOx au rapport air-carburant pauvre et la température (T_c) dudit catalyseur du NOx au rapport air-carburant pauvre qui sont inclues dans les variables d'état détectées dans ladite étape de détection des variables d'état,

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corriger la quantité de base d'hydrocarbure (HC_{base}) déterminé dans ladite étape de détermination de quantité d'alimentation en hydrocarbure de base lorsque la différence de température (ΔT) détectée dans ladite étape de détection de différence de température dévie d'une valeur prédéterminée (a ; 2a) correspondant à une quantité de chaleur générée par la quantité de base d'hydrocarbure (HC_{base}) délivrée dans ladite étape d'alimentation en hydrocarbure de façon à empêcher que la température (T_c) dudit catalyseur du NOx au rapport air-carburant pauvre puisse dévier à l'extérieur d'une fenêtre de température établie pour obtenir un taux d'épuration correct.

9. Procédé d'épuration des gaz d'émission d'échappement pour des moteurs à combustion interne selon la revendication 8, dans lequel ladite valeur prédéterminée (a ; 2a) est plus grande lorsque la température des gaz d'échappement (T_{gi}) au niveau de l'entrée dudit catalyseur du NOx au rapport air-carburant pauvre chute.

10. Procédé d'épuration des gaz d'émission d'échappement pour des moteurs à combustion interne selon la revendication 8 ou 9, dans lequel ladite étape de correction de quantité d'alimentation en hydrocarbure utilise une fonction linéaire pour corriger la quantité de base d'hydrocarbure (HC_{base}) en conformité avec la différence de température (ΔT).

11. Procédé d'épuration des gaz d'émission d'échappement pour des moteurs à combustion interne selon la revendication 8, dans lequel ladite étape de détection des variables d'état inclut les étapes consistant à détecter la quantité d'air d'admission (Q_a) du moteur à combustion interne, et à détecter la température (T_c) dudit catalyseur du NOx au rapport air-carburant pauvre.

12. Procédé d'épuration des gaz d'émission d'échappement pour des moteurs à combustion interne selon la revendication 11, dans lequel dans ladite étape de détection de température du catalyseur au rapport air-carburant pauvre, la température des gaz d'échappement (T_{go}) est détectée au niveau de la sortie du catalyseur du NOx au rapport air-carburant pauvre.

13. Procédé d'épuration des gaz d'émission d'échappement pour des moteurs à combustion interne selon la revendication 8, dans lequel ladite étape de détection des variables d'état inclut les étapes consistant à détecter la quantité d'air d'admission (Q_a) du moteur à combustion interne, et à détecter la vitesse de rotation du moteur à combustion interne.

14. Procédé d'épuration des gaz d'émission d'échappement pour des moteurs à combustion interne selon la revendication 8, dans lequel dans ladite étape de détection de différence de température, la différence (ΔT) dans la température des gaz d'échappement est détectée entre l'entrée et la sortie dudit catalyseur du NOx au rapport air-carburant pauvre.

Fig.1

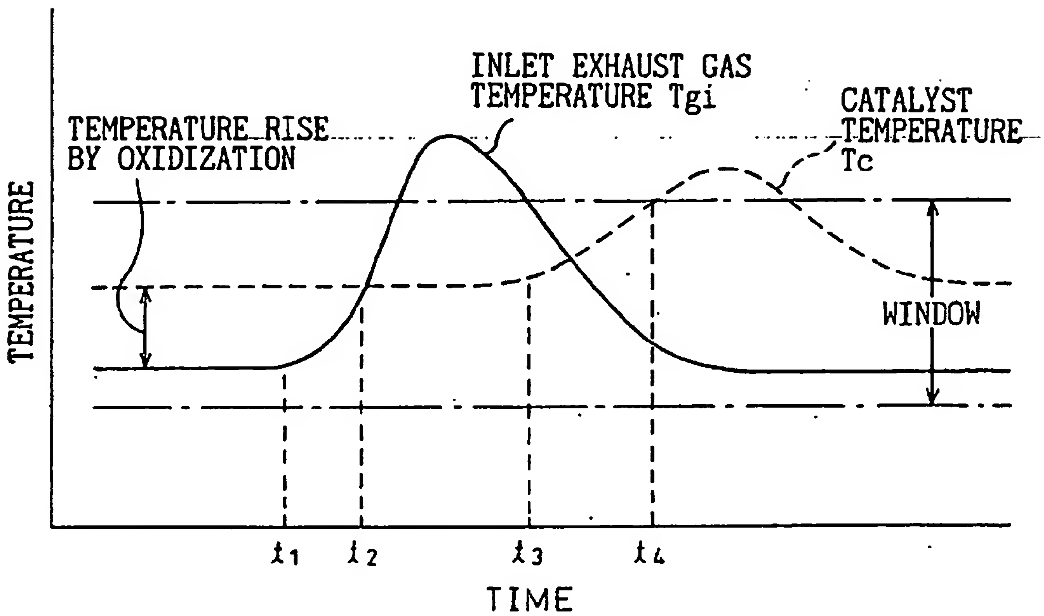

INLET EXHAUST GAS
TEMPERATURE Tgi
CATALYST
TEMPERATURE
Tc
TEMPERATURE RISE
BY OXIDIZATION
TEMPERATURE
WINDOW
t1
t2
t3
t4
TIME

Fig.2

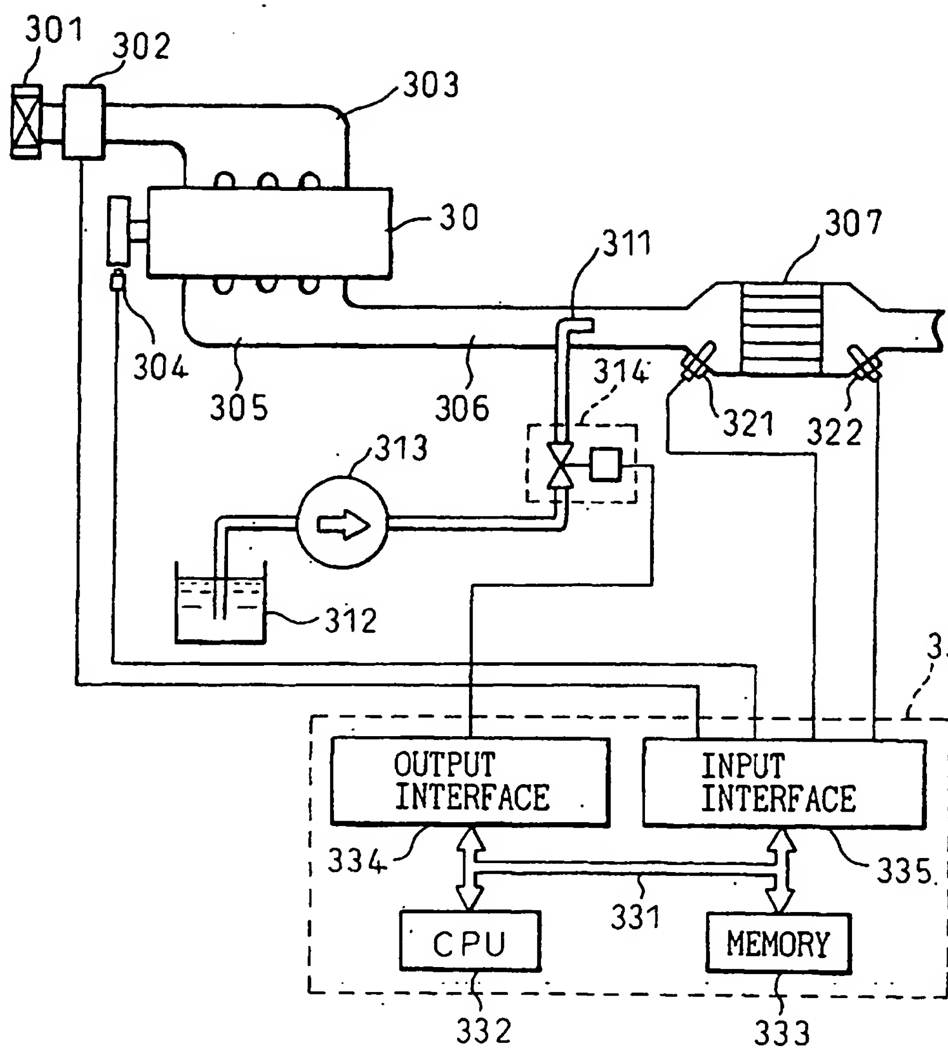

301
302
303
30
307
311
304
305
306
314
321
322
313
312
33
OUTPUT INTERFACE
INPUT INTERFACE
334
335
331
CPU
MEMORY
332
333

Fig.3

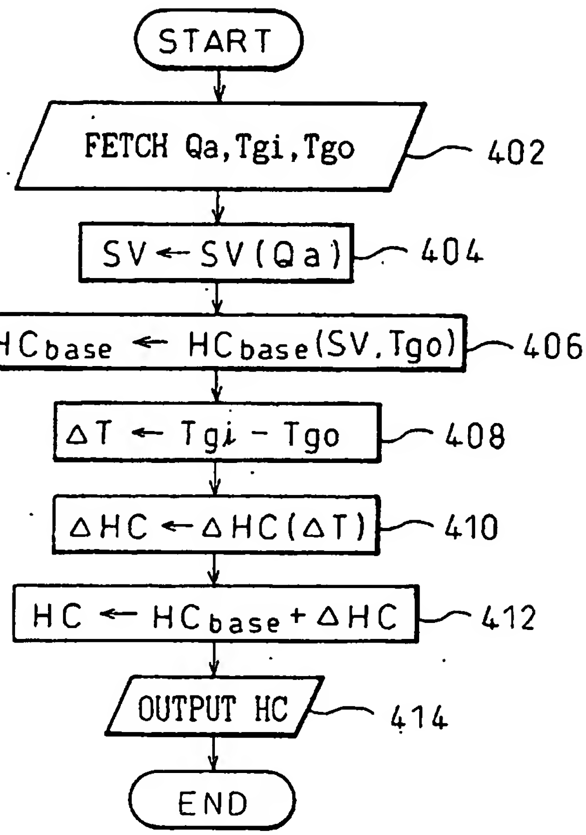

START
FETCH Qa,Tgi,Tgo
402
SV ← SV(Qa)
404
HCbase ← HCbase(SV,Tgo)
406
ΔT ← Tgi − Tgo
408
ΔHC ← ΔHC(ΔT)
410
HC ← HCbase + ΔHC
412
OUTPUT HC
414
END

Fig.4

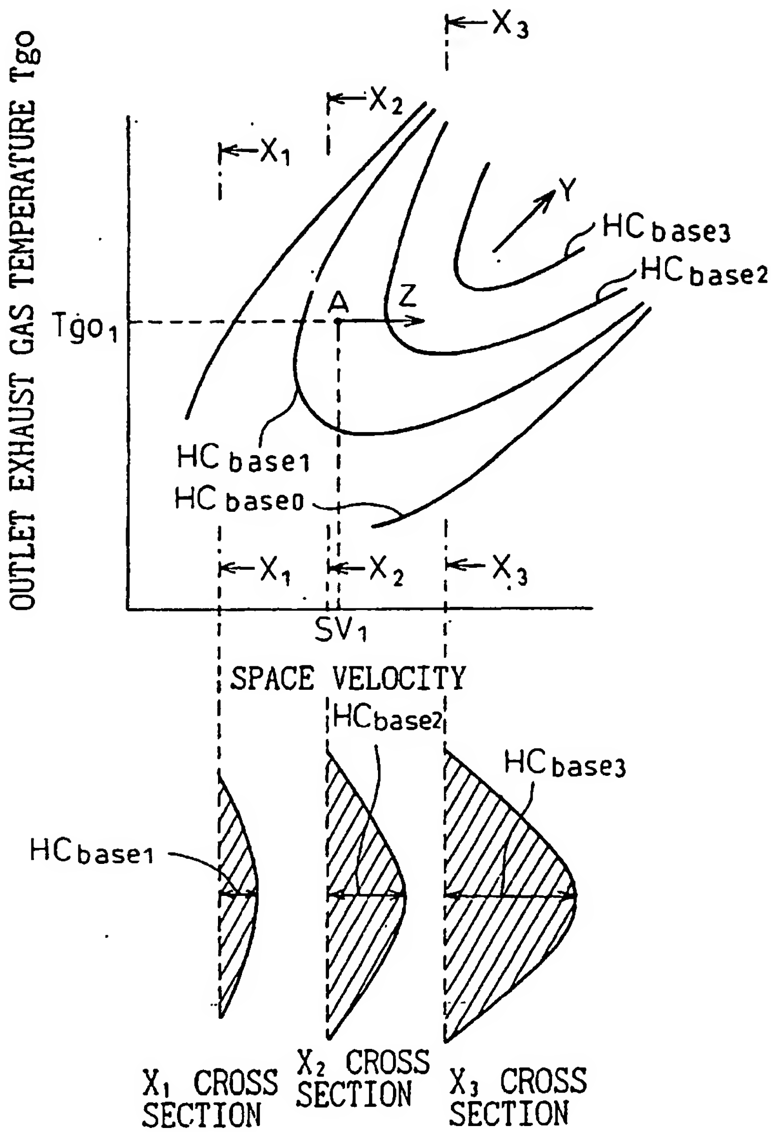
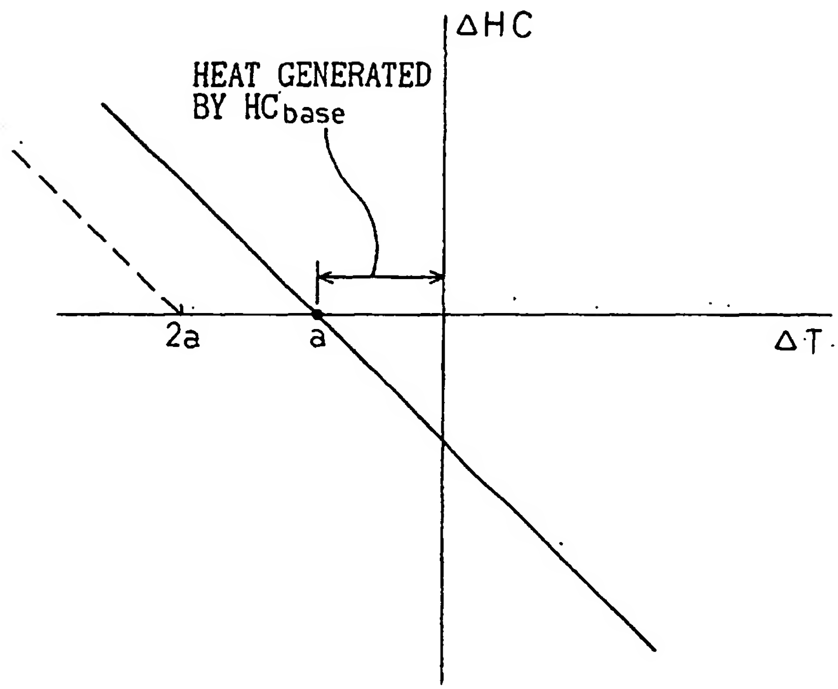

OUTLET EXHAUST GAS TEMPERATURE Tgo
Tgo1
X1
X2
X3
Y
Z
A
HC base3
HC base2
HC base1
HC base0
SV1
SPACE VELOCITY
HCbase2
HCbase3
HCbase1
X1 CROSS SECTION
X2 CROSS SECTION
X3 CROSS SECTION

Fig.5



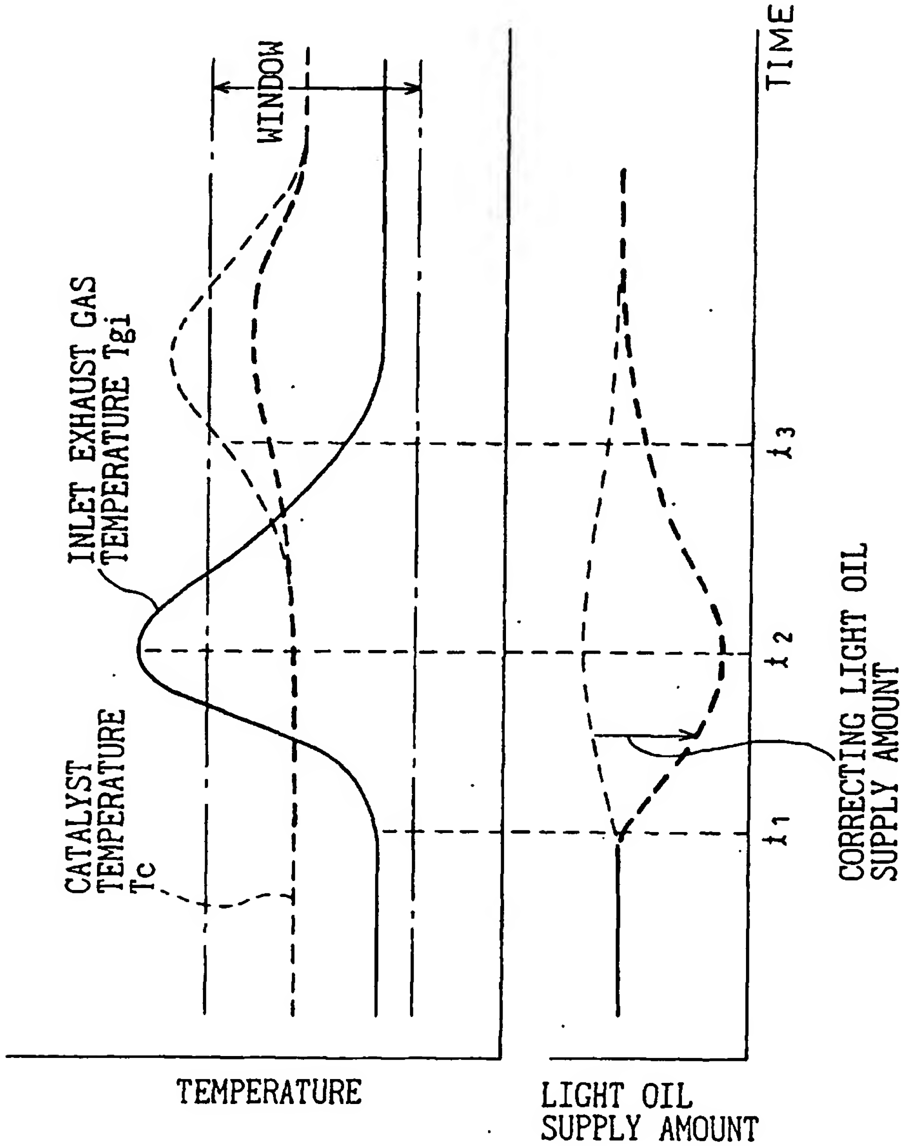

WINDOW
INLET EXHAUST GAS
TEMPERATURE Tgi
CATALYST
TEMPERATURE
Tc
TEMPERATURE
TIME
t1
t2
t3
CORRECTING LIGHT OIL
SUPPLY AMOUNT
LIGHT OIL
SUPPLY AMOUNT

Fig.6A

Fig.6B